

# **Relativistic Heavy Ion Collider Facility**

## **Facility Environmental Monitoring Report**

**Calendar Year 2004**



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## **Relativistic Heavy Ion Collider**

### **Facility Environmental Monitoring Report**

#### ***Summary of Results***

*In CY 2004, no significant environmental impacts from RHIC operations were identified. Tritium was not detected in any of the groundwater samples collected near potential soil activation areas. Although a trace level of tritium (300 pCi/L) was apparently detected in one water sample from the Peconic River downstream of the beam stop area, the level was very close to the analytical detection limit, and tritium was not detected in subsequent samples.*

*The ambient external exposures were measured for the RHIC ring area using 23 environmental TLDs. The average quarterly exposures for all TLD locations around the RHIC ring were  $16.7 \pm 1.9$ ,  $15.1 \pm 1.5$ ,  $15.1 \pm 1.2$ , and  $17.1 \pm 1.6$  mrem, respectively. The dose variation was statistically insignificant in each quarter and the annual dose was within the natural background dose levels on the BNL site.*

*There were no SPDES permit excursions attributable to RHIC activities in 2004.*

#### **Background**

Beam line interaction with the Relativistic Heavy Ion Collider's (RHIC) collimators and beam stops will produce secondary particles that will interact with some of the soils surrounding the 8 o'clock and 10 o'clock portions of the RHIC tunnel, and at the W-Line stop. These interactions can result in the production of a variety of radionuclides, of which tritium and sodium-22 can be leached out of the soils by rainwater. BNL installed impermeable geotextile caps over these areas to prevent rainwater infiltration into the potentially activated soil shielding. Additionally, discharges from RHIC cooling systems have the potential to impact surface and groundwater quality.

#### **Environmental Monitoring Program**

As required by DOE Order 450.1, *Environmental Protection Program*, (DOE, 2003) BNL has established an environmental monitoring program at the RHIC facility to evaluate potential impacts to environmental quality from its operation and to demonstrate compliance with DOE requirements and applicable federal, state, and local laws and regulations. Discharges from the RHIC cooling systems are monitored and regulated under New York's State Pollutant Discharge Elimination System (SPDES) permit program.

The environmental monitoring program for the RHIC facility is described in the *BNL Environmental Monitoring Plan* (BNL, 2004). The monitoring results and recommendations are summarized below.

## **Monitoring Results**

### **Groundwater Monitoring**

BNL monitors 13 wells at the RHIC facility to provide a means of verifying that the operational and engineered controls (i.e., impermeable caps) implemented at the beam stops and collimators are effective in protecting groundwater quality. Six monitoring wells were installed in the Blue and Yellow Line beam stop area, six wells in the collimator area, and one well near the W-Line beam stop (Figure 1). The primary focus of the monitoring program is the detection of tritium because it is the most easily leached radionuclide from activated soils, is highly mobile in groundwater, and has a long half-life compared to other soil activation products (12.3 years for tritium compared to 2.6 years for sodium-22).

Groundwater samples were collected from the 13 RHIC monitoring wells on a semiannual schedule during 2004. These samples were analyzed for tritium (Table 1). As in all previous monitoring, tritium was not detected in any of the RHIC groundwater monitoring wells.

### **Peconic River Monitoring**

Because the southern beam stop is located within 200 feet of the culvert for the Peconic River, surface water samples are collected to verify that potentially activated groundwater is not being discharged to the streambed during high water table conditions. When surface water is present, water samples are collected at an upstream location HY near Upton Road and at downstream location HV near the Ring Road (Figure 1). During 2004, surface water samples were collected four times from upstream location HY (025-650) and downstream location HV (026-650). The samples were analyzed for tritium and sodium-22. The samples are also periodically analyzed for inorganic parameters as part of the Peconic River surveillance program.

No tritium or sodium-22 was detected in any of the samples from upstream location HY, and sodium-22 was not detected in samples from downstream location HV. A trace level of tritium (300 pCi/L) was apparently detected in one sample from downstream location HV (Table 2). However, given the low detection limit for the analysis (200 pCi/L) and uncertainty in the measurement ( $\pm 160$  pCi/L), the result was “J” (estimated) qualified. Tritium was not detected in any of the other samples from location HV.

As in past years, HY surface water samples were slightly elevated for a number of inorganic parameters. In February 2004, chloride levels reached a maximum of 258 mg/L and sodium levels reached 149 mg/L (the NYS AWQS for chloride is 250 mg/L, and 20

mg/L for sodium). These elevated concentrations are likely to be attributed to winter roadway salt applications along Upton Road, William Floyd Parkway, and other upstream sources. Elevated concentrations of aluminum, iron, lead, and zinc occurred throughout the year. These elevated concentrations are attributed to road runoff and suspended sediment within the samples, since filtered samples from this location resulted in significantly lower concentrations.

## **Environmental TLDs**

The main purpose of ambient external exposure monitoring is to measure the dose to members of the public and uninvolved workers could receive from direct gamma radiation sources. These exposure measurements are also used to estimate ambient external dose to biota in the vicinity of RHIC. Twenty-three environmental thermoluminescent dosimeters (TLDs) are placed at strategic locations around the RHIC ring to measure direct penetrating radiation exposures (Figure 2).

TLD results from RHIC are compared with the average on-site exposures to estimate the dose contribution, if any, from RHIC operations above the natural background levels of radiation. The average quarterly exposures for all the locations around RHIC ring were  $16.7 \pm 1.9$ ,  $15.1 \pm 1.5$ ,  $15.1 \pm 1.2$ , and  $17.1 \pm 1.6$  mrem, respectively (Table 3). The dose variation was statistically insignificant in each quarter and the annual average doses were similar to the natural background dose levels on BNL site. Therefore, there was no additional dose contribution from RHIC operations.

## **SPDES Monitoring**

The SPDES permit authorizes discharges from the Sewage Treatment Plant (STP) to the Peconic River, and discharges of cooling water and stormwater to recharge basins. In the past, some sanitary wastes from the RHIC area were discharged to subsurface wastewater disposal systems. In 2001, a project to connect the entire RHIC site to BNL's sanitary sewer was completed. Monitoring of the site sanitary system is performed at the treated effluent discharge to the Peconic River.

Experimental cooling towers located at Buildings 1006, 1008, 1010, and 1002, cryogen cooling towers at 1005, and RF cooling systems at 1004 routinely discharge "blowdown" to either the ground surface or to the site stormwater collection system. Discharges from the Cryogenic Plant at Bldg. 1005, and Buildings 1006, 1008 and 1010 are conveyed to Basin HN (Outfall 002) (Figure 3). Discharges from Buildings 1002 and 1004 are conveyed to Outfall 002B. The discharges from these systems are regulated under the SPDES permit program. During 2004, these outfalls were monitored for flow and pH on a weekly basis and for residual corrosion control agents, oil and grease, volatile organic compounds, and aluminum, as required.

During CY 2004, there were no SPDES permit excursions associated with RHIC operations.

## Environmental Surveillance Monitoring

In addition to SPDES monitoring, all discharges to Outfall 002 (HN) are monitored quarterly for radionuclides, metals, volatile organic compounds, and water chemistry parameters as part of BNL's Environmental Surveillance Program. Outfall 002B, which receives cooling water discharges from Buildings 1002 and 1004, does not warrant surveillance monitoring at this time.

During 2004, no radionuclides related to Laboratory operations were detected in the discharges to basin HN. Gross alpha and beta readings were recorded for most samples collected in 2004. The maximum alpha concentration was  $2.6 \pm 1.3$  pCi/L, whereas the maximum gross beta concentration was  $7.9 \pm 1.6$  pCi/L for a sample collected on February 6, 2005. Because there were no gamma emitting nuclides detected, these gross counts are being attributed to natural radioactive materials. Tritium was detected just above the MDL of 170 pCi/L in one of the four samples collected in 2004, with a concentration of  $200 \pm 120$  pCi/L.

In 2004, as in the past, aluminum and iron were detected above the NYSDEC effluent limit. Because unfiltered sample concentrations were much higher than filtered concentrations, they are attributable to native sediments carried by stormwater runoff and/or corrosion products associated with piping for the cooling system. Low levels of trihalomethanes were sporadically detected in the discharges to Outfall 002. However, these compounds are common byproducts of potable water disinfection and are not attributable to RHIC operations. Acetone and methylene chloride were also detected in the discharge to Outfall 002. However, these compounds are sporadically detected in many basin discharge samples, and are commonly attributable to cross-contamination of samples in the analytical laboratory.

## Future Monitoring Actions

The following changes are recommended or in progress:

- Continue to sample groundwater monitoring wells semi-annually, and analyze samples for tritium only. If tritium is detected in any of the samples, resume gamma analyses for sodium-22.
- Continue to monitor RHIC discharges per SPDES permit requirements and as part of the BNL surveillance program.
- Continue ambient external exposure monitoring using environmental TLDs.

## References

BNL. 2004. *Brookhaven National Laboratory Environmental Monitoring Plan, Annual Update*. BNL-52676. Brookhaven National Laboratory, Upton, NY. January 2004.

DOE Order 5400.5. 1990. *Radiation Protection of the Public and the Environment*. U.S. Department of Energy, Washington, D.C. Change 2: 1-7-93.

**Table 1. Groundwater Monitoring: Tritium and Sodium-22 Results at the RHIC, CY 2004.**

Building/Facility	Well	Feb. 2- 18, 2004	Aug. 11-12, 2004
		-----pCi/L-----	
Northern Beam Stop Area	025-04	H3= <320	H3= <270
	025-07	H3= <310	H3= <270
	025-08	H3= <310	H3= <270
Southern Beam Stop Area	025-03	H3= <290	H3= <280
	025-05	H3= <310	H3= <270
	025-06	H3= <310	H3= <270
Northern Collimator	034-05	H3= <310	H3= <270
Southern Collimator	034-06	H3= <310	H3= <270
Downgradient of Collimator Area	043-01	H3= <310	H3= <210
	043-02	H3= <310	H3= <210
	044-13	H3= <310	H3= <270
	044-14	H3= <310	H3= <280
W-Line Beam Stop	044-29	H3= <310	H3= <220

## Notes:

"<" preceding a value (e.g., <383) indicates that the measured value was less than the MDL.

**Table 2. Tritium and Sodium-22 Concentrations in the Peconic River - Upstream and Downstream of the RHIC Beam Stop Areas, CY 2004.**

Location	Collection Date	Result (pCi/L)
HY: Upstream of RHIC Beam Stop Area (025-650)	02/02/04	H3 = < 310
		Na-22 = <12
	05/11/04	H3= < 200
		Na-22 = <11
	08/16/04	H3= < 220
		Na-22 = <12
	11/29/04	H3= < 220
		Na-22 = <16
HV: Downstream of RHIC Beam Stop Area (026-650)	02/04/04	H3= < 310
		Na-22 = <17
	05/11/04	H3= 300 +/- 160
		Na-22 = <11
	08/16/04	H3= < 270
		Na-22 = <12
	11/29/04	H3= < 220
		Na-22 = <21

**Notes:**

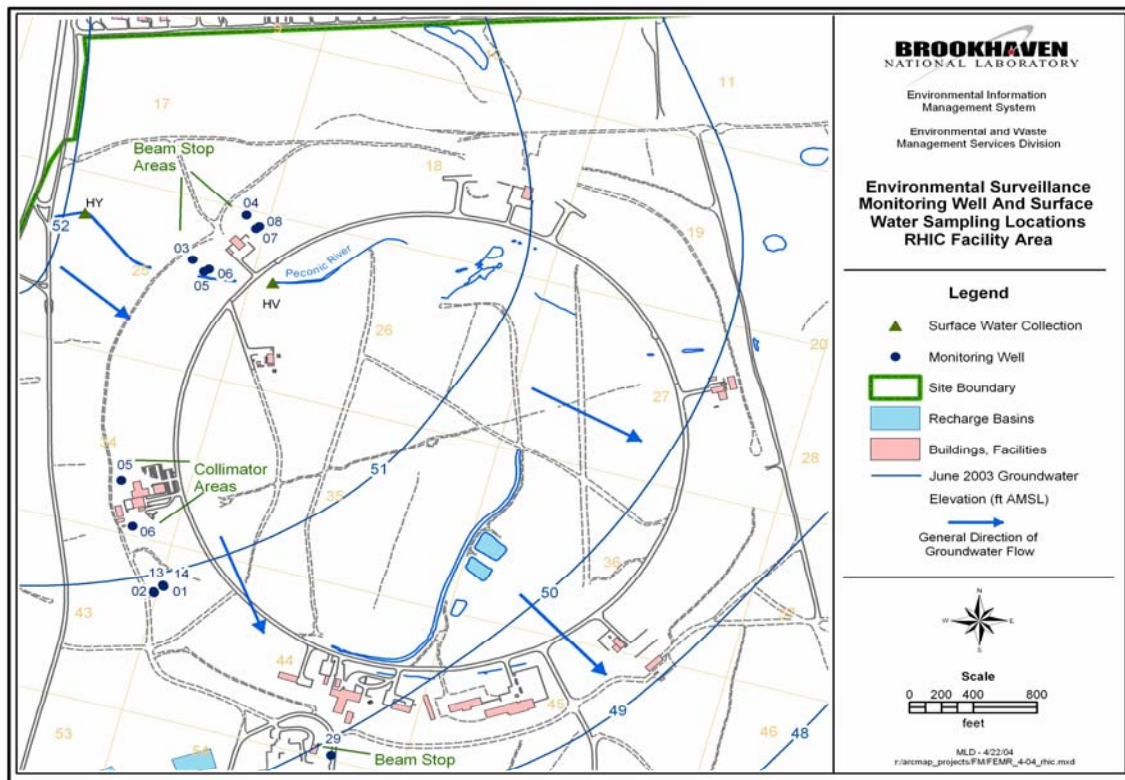
Ability to collect surface water samples is limited to periods of high water table position when there is base flow in the river..

"<" Preceding a value (e.g., <200) indicates that the measured value was less than the MDL.

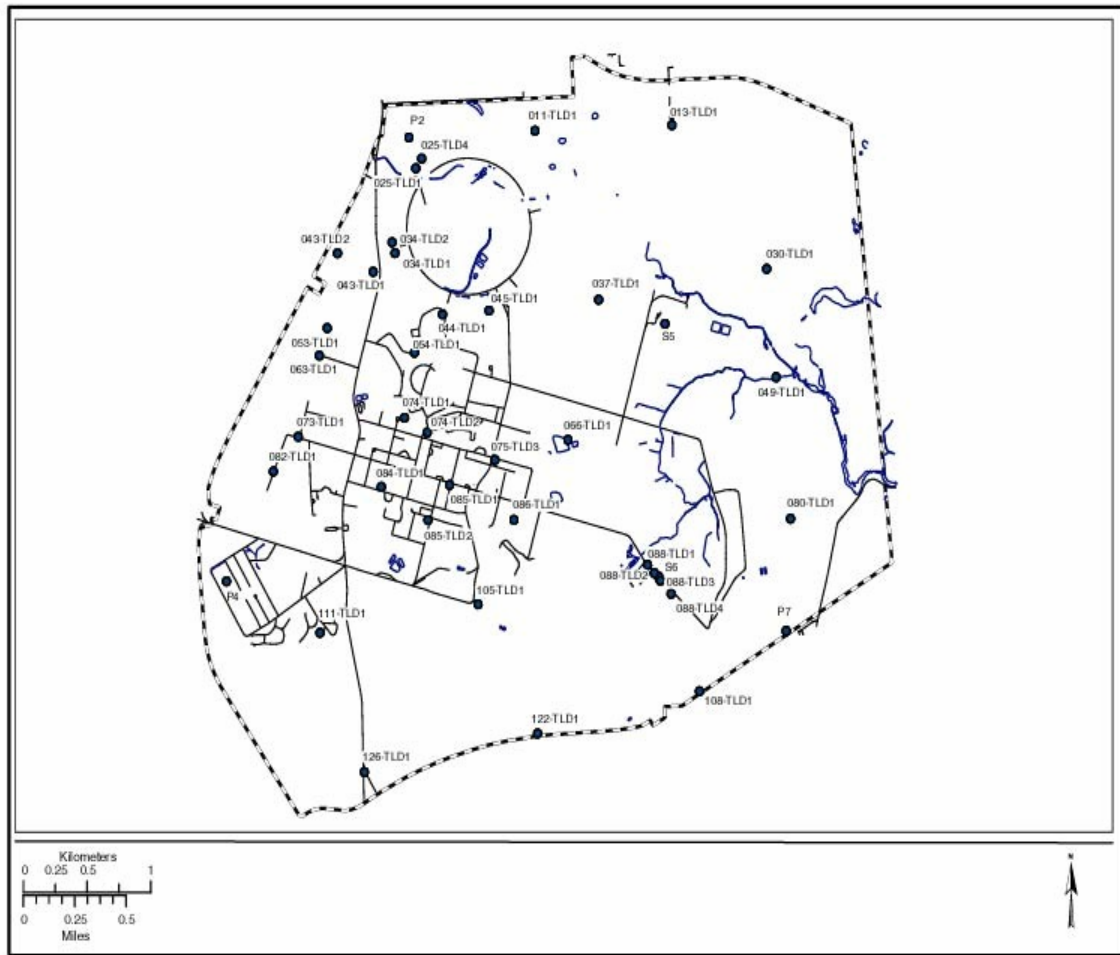
**Table 3. Quarterly Ambient Radiation at the RHIC, CY 2004.**

TLD #	Location	1 <sup>st</sup> Quarter	2 <sup>nd</sup> Quarter	3 <sup>rd</sup> Quarter	4 <sup>th</sup> Quarter
-----mRem-----					
011-TLD1	N. Firebreak	14.5	13.8	15.0	16.0
P2	P-2	13.9	14.2	12.8	13.8
025-TLD1	B#1010 St.1	17.9	13.4	14.3	16.7
025-TLD4	B# 1010 St. 4	16.7	14.1	14.9	16.7
027-TLD1	B#1002A South	15.5	15.9	13.8	14.9
027-TLD2	B#1002D East	15.3	16.5	13.5	15.2
034-TLD1	B#1008 C2	18.0	15.9	15.6	18.4
034-TLD2	B#1008 C4	18.2	14.9	15.4	17.7
036-TLD1	B#1004B East	16.7	13.3	14.3	15.3
036-TLD2	B#1004 East	20.4	19.3	17.0	20.4
037-TLD1	S-13	15.8	14.0	14.6	17.2
043-TLD1	N. Access Rd	17.5	15.9	15.6	18.0
043-TLD2	N. Met	16.6	15.7	16.6	17.6
044-TLD1	B #1006	15.2	14.9	14.5	16.4
044-TLD2	South of B# 1000E	15.3	15.1	15.1	17.0
044-TLD3	South of B#1000P	16.0	13.7	15.7	16.3
044-TLD4	B#1006N-NE1000P	21.3	16.4	17.2	20.4
044-TLD5	B#1006N-N 1000P	16.8	15.3	15.2	17.9
045-TLD1	B#1005S	18.7	17.3	16.1	16.1
045-TLD2	East of B#1005S	17.5	16.2	16.7	19.1
045-TLD3	S/E of B#1005S	16.2	14.6	15.4	17.6
045-TLD4	S/W of B#1005S	15.9	15.0	15.6	18.2
045-TLD5	WS/W of B# 1005S	13.8	13.0	12.8	16.2
<b>Mean</b>		<b>16.7 ± 1.9</b>	<b>15.1 ± 1.5</b>	<b>15.1 ± 1.2</b>	<b>17.1 ± 1.6</b>

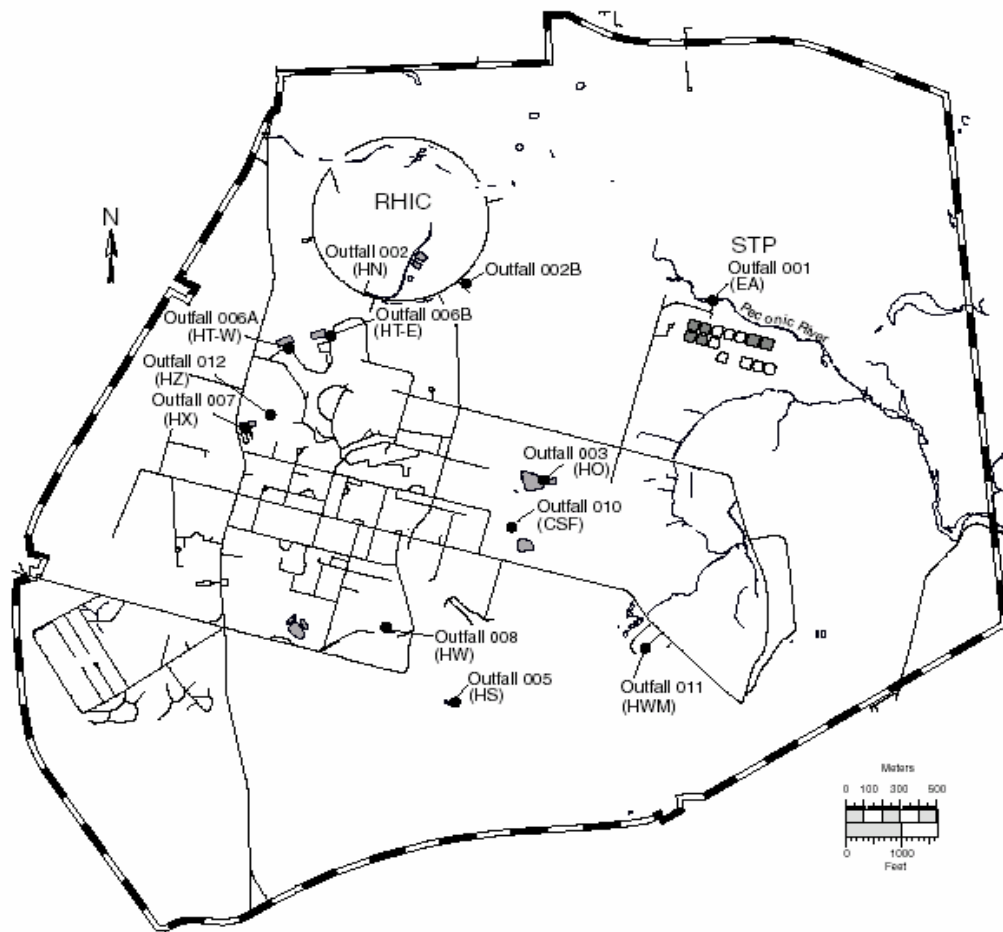




**Figure 1. Locations of RHIC Facility Groundwater Monitoring Wells, and surface water sampling locations.**



**Figure 2. Locations of Environmental TLDs for the BNL Site.**



**Figure 3. Location of SPDES-Permitted Outfalls.**